REMARKS

Claims 1-58 stand rejected. In view of the above amendment and following remarks, Applicants respectfully traverse the outstanding rejections and reconsideration and withdrawal of all grounds of rejection of pending claims 1-58 is respectfully requested.

Amendment to the Claims

Claims 1, 29, 55, 56, and 58 have been amended to more clearly define the subject matter of Applicants' invention. Specifically, each claim is amended to recite that the invention is implemented in a fashion that is non-invasive to the pipeline. Support for these amendments is found in the originally filed application at least in the title and at page 3, lines 3-4, Figure 1, and in the Abstract on page 37.

Levesque in Combination with Thompson Fails to Teach or Suggest the Claimed Invention

U.S. Patent No. 5,392,652 to Levesque *et al.* (hereinafter "Levesque") in combination with U.S. Patent No. 4,092,868 to Thompson *et al.* (hereinafter "Thompson"), fails to teach or suggest the invention of claims 1-8, 11-18, 20-25, 28-44, and 46-58.

Independent claims 1 is directed to a pipeline inspection system. In general and in relevant part, the pipe inspection system includes a wave launcher in communication with a pipeline. The wave launcher is adapted to transmit an input waveform having a selected input energy along a longitudinal axis of the pipeline. The wave launcher is also adapted to receive a reflected component of the input waveform from the pipeline. Further, the pipeline inspection system includes a processor adapted to compare the input waveform with the reflected component of the input waveform to determine a characteristic of the pipeline. The transmitting, receiving, generating, and comparing steps are performed in a fashion that is non-invasive to the pipeline.

In contrast, Levesque generally is directed to a method and apparatus used to inspect metallic objects with a variable angle ultrasonic transducer (see col. 6, lines 4-8). The ultrasonic transducer transmits an ultrasonic sound wave incident upon the member under test (see col. 7, lines 9-12). Levesque also discloses receiving a reflection of the ultrasonic sound waves

propagated within the metallic object to indicate the presence of an abnormality in the metallic object (see col. 12, lines 31-34). Further, Levesque teaches a device positioned on the surface of the object so that the device can be repositioned based on irregularities in the surface (see FIG. 8 and col. 5, lines 10-20). Levesque does not, however, teach or suggest comparing an input waveform with a reflected component of the input waveform to determine a characteristic of the metallic object, as recited in claims 1, 29, 55, 56, and 58. Instead, Levesque discloses a computer system that receives signals "correlated to the degree of axial and vertical displacement of the [ultrasonic] transducer, and which continually and automatically calculates the degree of repositioning of the transducer required to accommodate the irregularity by maintaining the beam angle constant." (col. 7, lines 29-41).

Thompson fails to remedy the deficiencies of Levesque at least because Thompson fails to teach or suggest comparing a waveform input into a pipeline with a reflected component of the input waveform in a non-invasive fashion, as recited in amended claims 1, 29, 55, 56, and 58. Instead, Thompson discloses an apparatus that transmits an input waveform, receives a reflected waveform, and compares the waveforms as the apparatus moves in an invasive manner through the pipe (see col. 3, lines 15-22 and cols. 3-4, lines 62-15). Unlike Applicants' invention, Thompson-like devices pose a serious blockage to the normal fluid flow through the pipeline and may require several days for the inspection of a lengthy pipeline (see Applicants' specification at page 1, line 24 – page 2, line 2).

Since neither Levesque nor Thompson teach or suggest comparing an input waveform with a reflected waveform while inspecting the pipeline in a non-invasive manner as recited in amended claims 1, 29, 55, 56, and 58, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of those claims over Levesque in view of Thompson. Further, as claims 2-28, 30-54, and 57 depend from claims 1, 29, 55, and 56, respectively, and recite further limitations thereon, Applicants respectfully submit that these claims are allowable as well. Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of those claims.

The Levesque/Thompson Combination is Improper

M.P.E.P. § 2143.01 states that a proposed modification cannot change the principles of the operation of the prior art invention being modified. In contrast to suggesting the desirability of a combination, the cited references (an inspection device that calculates a degree of repositioning of a transducer based on surface irregularities of a pipeline that the transducer travels along and an inspection device that compares a transmitted waveform and a received waveform by invasively inspecting a pipeline) teach away from the asserted combination. For example, adding a Thompson-like device which transmits, receives, and compares waveforms by invasively inspecting a pipeline to the Levesque-like transducer renders both inoperable. In particular, as the Levesque device is positioned on the surface of the pipeline so that the device can be repositioned based on surface irregularities, the invasive comparison performed in a Thompson-like device cannot be achieved using a Levesque-like device. Similarly, the external, non-invasive testing of Levesque cannot be performed in a Thompson-like invasive manner. Since Levesque cannot operate by inspecting the pipeline in an invasive manner and Thompson cannot compare waveforms while inspecting a pipeline in a non-invasive manner, Applicants submit that the combination of the cited references is improper and respectfully request that the Examiner reconsider and withdraw all the §103 rejections based on the Levesque / Thompson combination.

Furthermore, M.P.E.P. § 2143.01 states that "[t]he mere fact that references can be combined does not render the resultant combination obvious unless the prior art suggests the desirability of the combination." In re Mills, 916 F.2d 680, 16 U.S.P.Q. 1430 (Fed. Cir. 1990). As explained above, the cited references teach away from the asserted combination. Further, the Office Action fails to point out and Applicants fail to find any suggestion or motivation in either Levesque or Thompson to combine these references. Neither Levesque nor Thompson suggest any unresolved challenges with respect to comparing an input waveform with a reflected component of the waveform in a non-invasive fashion, and using Applicants' own invention to supply the motivation for combining references is inappropriate.

Since neither Levesque nor Thompson teach or suggest comparing an input waveform with a reflected component of the waveform while inspecting a pipeline in a non-invasive

fashion as recited in claims 1, 29, 55, 56, and 58, and since there is no objective suggestion or motivation in either reference to combine those references, Applicants respectfully request that the Examiner reconsider and allow claims 1, 29, 55, 56, and 58. Because claims 2-28, 30-54, and 57 depend from claims 1, 29, 55, and 56 and recite further limitations thereon, Applicants respectfully submit that these claims are allowable as well. Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claims 1-58.

Unterberger Fails to Remedy the Defects of Levesque

Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Levesque in view of U.S. Patent 3,634,753 to Unterberger ("Unterberger"). The arguments presented above with respect to Levesque and Thompson apply here in equal force and are reiterated as if set forth in full.

Unterberger discloses a method for dynamically measuring the thickness of ice layers in order to determine whether such ice thickness is capable of supporting a moving vehicle (col. 6, lines 59-63). Unterberger does not teach or suggest any pipe inspection system whatsoever. Instead, Unterberger discloses measuring the thickness of ice layers with an antenna array that radiates a continuous wave.

Since Levesque fails to teach or suggest comparing an input waveform with a reflected waveform while inspecting a pipeline in a non-invasive manner as recited in amended claim 1, and Unterberger fails to teach or suggest any pipe inspection system whatsoever, Applicants respectfully request that the Examiner reconsider and withdraw the §103 rejection of claims 9 and 10, which depend from claim 1 and recite further limitations thereon.

Jean Fails to Remedy the Defects of Levesque

Claims 19 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Levesque in view of U.S. Patent 5,455,516 to Jean et al. ("Jean"). The arguments presented above with respect to Levesque and Thompson apply here in equal force and are reiterated as if set forth in full.

Jean discloses an electromagnetic property meter for the measurement of a parameter of a material which may be determined by measuring the electromagnetic properties of the material

under investigation. The meter has a material measurement chamber which permits material to flow through the chamber to determine the dielectric and conductive properties of the material filling the chamber (see col. 23, lines 43-50, col. 7, lines 44-54). As Jean operates by filling a chamber with the material to be measured, Jean does not teach or suggest any pipe inspection system whatsoever.

Since Levesque fails to teach or suggest comparing an input waveform with a reflected waveform while inspecting the pipeline in a non-invasive manner as recited in amended claims 1 and 29, and since Jean fails to teach or suggest any pipe inspection system whatsoever, Applicants respectfully request that the Examiner reconsider and withdraw the §103 rejection of claims 19 and 45, which depend from claims 1 and 29, respectively, and recite further limitations thereon.

Gnauck Fails to Remedy the Defects of Levesque

Claims 26 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Levesque in view of U.S. Patent 5,303,079 to Gnauck et al. ("Gnauck"). The arguments presented above with respect to Levesque and Thompson apply here in equal force and are reiterated as if set forth in full.

Gnauck discloses an apparatus for externally modulating an optical beam. The apparatus adjusts a modulation chirp parameter in a controllable manner to control external modulation of the optical beam. Identical input optical beams are supplied to the waveguides, the chirp parameter is adjusted, and the signals emerging from the waveguides are combined to form a single output signal suitable for transmission over an optical fiber (col. 2, lines 24-44). Gnauck does not teach or suggest any pipe inspection system whatsoever. Instead, Gnauck discloses combining two optical signals emerging from independent waveguides into a single modulated optical beam.

Since Levesque fails to teach or suggest comparing an input waveform with a reflected waveform while inspecting the pipeline in a non-invasive manner as recited in amended claim 1, and Gnauck fails to teach or suggest any pipe inspection system at all, Applicants respectfully

request that the Examiner reconsider and withdraw the §103 rejection of claims 26 and 27, which depend from claim 1 and recite further limitations thereon.

The Proposed Combination of Levesque with Unterberger, Jean, or Gnauck Is Improper

M.P.E.P. § 2143.01 states that "[t]he mere fact that references can be combined does not render the resultant combination obvious unless the prior art suggests the desirability of the combination." In re Mills, 916 F.2d 680, 16 U.S.P.Q. 1430 (Fed. Cir. 1990). The Office Action fails to point out and Applicants fail to find any suggestion or motivation in either Unterberger, Jean, or Gnauck to combine any of these references with Levesque. Neither Unterberger Jean, nor Gnauck teach or suggest any pipeline inspection system whatsoever, and using Applicants' own invention to supply the motivation for combining references is inappropriate.

Further, M.P.E.P. § 2143.01 also states that a proposed modification cannot change the principles of the operation of the prior art invention being modified. In contrast to suggesting the desirability of a combination, the cited references (a method for dynamically measuring the thickness of ice layers, an electromagnetic property meter measuring the electromagnetic properties of a material by filling a material measurement chamber, and an apparatus that combines optical beams emerging from two waveguides to form a single output signal) teach away from the asserted combination. For example, a Jean-like device cannot be performed without filling a material measurement chamber with a material to be measured. Since Jean cannot operate without the filling of the material measurement chamber, and therefore in an invasive fashion, Applicants submit that the Levesque / Jean combination is improper. Further, combining a Gnauck-like device with a Levesque-like device renders both inoperable. In particular, as the Gnauck-like device combines optical beams emerging from two waveguides, the Levesque-like device which compares an input waveform and a reflected waveform in a non-invasive fashion in a single pipeline cannot be achieved.

Since neither Unterberger, Jean, nor Gnauck teach or suggest any pipeline inspection applications and since there is no objective suggestion or motivation in any of the cited references to combine such references, Applicants respectfully request that the Examiner reconsider and allow claims 9, 10, 19, 26, 27, and 45.

Applicants Request an Affidavit

If the Examiner maintains any of the rejections of claims 1-8, 11-18, 20-25, 28-44, and 46-58 over the Levesque / Thompson combination, claims 9 and 10 over the Levesque / Unterberger combination, claims 19 and 45 over the Levesque / Jean combination, and claims 26 and 27 over the Levesque / Gnauck combination, Applicants respectfully request that the Examiner point out with specificity where in the references there exists a motivation for any of the cited combinations, point out with particularity a teaching in another prior art publication providing such a motivation, or provide an affidavit, detailing the Examiner's own personal knowledge upon which he is relying for the motivation for each cited combination, as required by M.P.E.P. § 2143.03.

CONCLUSION

In view of the foregoing, Applicants respectfully request that the Examiner pass claims 1-58 to allowance. The Examiner is invited to contact Applicants' undersigned representative by telephone at the number listed below to discuss any outstanding issues.

Respectfully submitted,

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MARKED UP VERSION OF AMENDED CLAIMS SHOWING AMENDMENT

1. A pipeline inspection system comprising,

a wave launcher in communication with a pipeline and adapted to transmit an input waveform having a selected input energy along a longitudinal axis of said pipeline, and to receive a reflected component of said input waveform from said pipeline, said reflected component having a characteristic reflected energy,

an analyzer in communication with said wave launcher and adapted to generate said input waveform, and to receive said reflected component of said input waveform from said wave launcher, and

a processor in communication with said analyzer and adapted to compare said input waveform with said reflected component of said input waveform to determine a characteristic of said pipeline,

wherein the wave launcher, the analyzer, and the processor operate in a fashion that is non-invasive to the pipeline.

29. A method of inspecting a characteristic of a pipeline, said method comprising,

transmitting an input waveform having a selected input energy along a longitudinal axis of said pipeline,

receiving a reflected component of said input waveform from said pipeline, said reflected component having a characteristic reflected energy, and

comparing said input waveform with said reflected component of said input waveform to determine said characteristic of said pipeline,

wherein the transmitting, receiving, and comparing steps occur in a fashion that is non-invasive to the pipeline.

55. A method of determining a location of a point along a pipeline, said method comprising,

transmitting an input waveform having a selected input energy along a longitudinal axis of said pipeline,

receiving a reflected component of said input waveform from said pipeline, said reflected component having a characteristic reflected energy, and

comparing said input waveform with said reflected component of said input waveform to determine said location of said point along said pipeline,

wherein the transmitting, receiving, and comparing steps occur in a fashion that is non-invasive to the pipeline.

56. A method of inspecting a characteristic of a pipeline, said method comprising,

transmitting an input waveform having a selected input energy along a longitudinal axis of said pipeline,

receiving a reflected component of said input waveform from said pipeline, said reflected component having a characteristic reflected energy, and

determining said characteristic of said pipeline using an error estimate, said error estimate depending on a known point along said pipeline relative to said characteristic,

wherein the transmitting, receiving, and determining steps occur in a fashion that is non-invasive to the pipeline.

58. A method of inspecting a characteristic of a pipeline, said method comprising,

generating an input waveform,

launching said input waveform into said pipeline,

receiving from said pipeline a reflected component having a characteristic reflected energy of said input waveform,

calculating a mathematical function of said characteristic reflected energy from said reflected component of said input waveform,

determining a model mathematical function of model reflected energy from a model component of a model input waveform, and

determining said characteristic of said pipeline by comparing said mathematical function of said reflected energy to said model mathematical function of said model reflected energy,

wherein each step is performed in a fashion that is non-invasive to the pipeline.

CLEAN COPY OF CLAIMS

1. (Amended) A pipeline inspection system comprising,

a wave launcher in communication with a pipeline and adapted to transmit an input waveform having a selected input energy along a longitudinal axis of said pipeline, and to receive a reflected component of said input waveform from said pipeline, said reflected component having a characteristic reflected energy,

an analyzer in communication with said wave launcher and adapted to generate said input waveform, and to receive said reflected component of said input waveform from said wave launcher, and

a processor in communication with said analyzer and adapted to compare said input waveform with said reflected component of said input waveform to determine a characteristic of said pipeline,

wherein the wave launcher, the analyzer, and the processor operate in a fashion that is non-invasive to the pipeline.

2. The apparatus of claim 1, wherein said processor is further adapted to compare said input waveform with said reflected component to detect an anomaly in said pipeline.

3. The apparatus of claim 2, wherein said anomaly is at least one of a crack, a corrosion, a leak, a location of an end wall, an obstruction, a flange, a weld, and a restriction in said pipeline.

4. The apparatus of claim 2, wherein said processor is further adapted to compare said input waveform with said reflected component to determine a location of said anomaly in said pipeline.

5. The apparatus of claim 2, wherein said processor is further adapted to compare said input waveform with said reflected component to determine a shape of said anomaly in said pipeline.

6. The apparatus of claim 2, wherein said processor is further adapted to compare said input waveform with said reflected component to determine one of an absolute size of said anomaly and a relative size of said anomaly relative to an internal diameter of said pipeline.

7. The apparatus of claim 1, wherein said processor is further adapted to compare said input waveform with said reflected component to determine an axial curvature in said pipeline.

8. The apparatus of claim 1, wherein said processor is further adapted to compare said input waveform with said reflected component to determine location points along said pipeline relative to an initial known location.

9. The apparatus of claim 1, wherein said wave launcher further comprises a probe antenna, said probe antenna adapted for transmitting said input waveform into said pipeline.

10. The apparatus of claim 9, wherein said probe antenna of said wave launcher is in physical contact with said pipeline.

11. The apparatus of claim 1, wherein said analyzer is further adapted to detect said reflected component along said longitudinal axis of said pipeline.

12. The apparatus of claim 1, wherein said processor is further adapted to generate a mathematical model representative of said pipeline.

13. The apparatus of claim 12, wherein said mathematical model is ideal.

14. The apparatus of claim 12, wherein said mathematical model is lossy.

15. The apparatus of claim 12, wherein said mathematical model is one of an averaging model and a cross-sectional model.

16. The apparatus of claim 12, wherein said processor is further adapted to generate a model transfer function relating a model input waveform to a model reflected component, an actual transfer function relating an actual input waveform to an actual reflected component, and to determine said characteristic at least in part by comparing said model transfer function with said actual transfer function.

17. The apparatus of claim 12, wherein said processor is further adapted to determine said characteristic of said pipeline at least in part by comparing an actual reflected component with a model reflected component.

18 The apparatus of claim 1, wherein said analyzer is further adapted to extract a characteristic energy and phase for said input waveform and said reflected component.

19. The apparatus of claim 1, wherein said analyzer is further adapted to generate said input waveform with a frequency above a characteristic cutoff frequency of said pipeline.

20. The apparatus of claim 1, wherein said analyzer is further adapted to generate said input waveform at a frequency within a range of frequencies for which a dominant mode for said pipeline exists.

21. The apparatus of claim 20, wherein said input waveform comprises a plurality of input signals within said range of frequencies.

22. The apparatus of claim 21, wherein said analyzer is further adapted to detect differences in velocity between said plurality of input signals as said input signals propagate in said pipeline, and said processor is further adapted to determine a curvature of said pipe along said longitudinal axis from said differences in velocity.

23. The apparatus of claim 21, wherein said analyzer is further adapted to detect differences in velocity between reflected components of each of said plurality of input signals to determine a curvature of said pipeline along said longitudinal axis.

24. The apparatus of claim 1, wherein said analyzer is further adapted to generate an electromagnetic waveform as said input waveform.

25. The apparatus of claim 1, wherein said analyzer is further adapted to generate an acoustic waveform as said input waveform.

26. The apparatus of claim 1, wherein said analyzer is further adapted to generate said input waveform as one of a spread spectrum waveform, a chirp waveform, and a soliton waveform.

27. The apparatus of claim 1, wherein said analyzer is further adapted to generate said input waveform as a wideband waveform.

28. The apparatus of claim 1 further comprising calibration elements adapted to temperature stabilize said analyzer

29. (Amended) A method of inspecting a characteristic of a pipeline, said method comprising,

transmitting an input waveform having a selected input energy along a longitudinal axis of said pipeline,

receiving a reflected component of said input waveform from said pipeline, said reflected component having a characteristic reflected energy, and

comparing said input waveform with said reflected component of said input waveform to determine said characteristic of said pipeline,

wherein the transmitting, receiving, and comparing steps occur in a fashion that is non-invasive to the pipeline.

30. The method of claim 29 further comprising, comparing said input waveform with said reflected component to detect an anomaly in said pipeline.

31. The method of claim 30, wherein said anomaly is at least one of a crack, a corrosion, a leak, a location of an end wall, an obstruction, a flange, a weld, and a restriction in said pipeline.

32. The method of claim 30 further comprising, comparing said input waveform with said reflected component to determine a location of said anomaly in said pipeline.

33. The method of claim 30 further comprising, comparing said input waveform with said reflected component to determine a shape of said anomaly in said pipeline.

34. The method of claim 30 further comprising, comparing said input waveform with said reflected component to determine one of an absolute size of said anomaly and a relative size of said anomaly relative to an internal diameter of said pipeline.

35. The method of claim 29 further comprising, comparing said input waveform with said reflected component to determine an axial curvature in said pipeline.

36. The method of claim 29 further comprising, comparing said input waveform with said reflected component to determine location points along said pipeline relative to an initial known location.

37. The method of claim 29, further comprising, detecting said reflected component along said longitudinal axis of said pipeline.

38. The method of claim 29 further comprising, generating a mathematical model representative of said pipeline.

39. The method of claim 38, wherein said mathematical model is ideal.

40. The method of claim 38, wherein said mathematical model is lossy.

41. The method of claim 38, wherein said mathematical model is one of an averaging model and a cross-sectional model.

42. The method of claim 38 further comprising, generating a model transfer function relating a model input waveform to a model reflected component, an actual transfer function relating an

actual input waveform to an actual reflected component, and to determine said characteristic at least in part by comparing said model transfer function with said actual transfer function.

43. The method of claim 38 further comprising, determining said characteristic of said pipeline at least in part by comparing an actual reflected component with a model reflected component.

44 The method of claim 29 further comprising, extracting a characteristic energy and phase for said input waveform and said reflected component.

45. The method of claim 29 further comprising, generating said input waveform with a frequency above a characteristic cutoff frequency of said pipeline.

46. The method of claim 29 further comprising, generating said input waveform at a frequency within a range of frequencies for which a dominant mode for said pipeline exists.

47. The method of claim 46, wherein said input waveform comprises a plurality of input signals within said range of frequencies.

48. The method of claim 47 further comprising, detecting differences in velocity between said plurality of input signals as said input signals propagate in said pipeline, and determining a curvature of said pipe along said longitudinal axis from said differences in velocity.

49. The method of claim 47 further comprising, detecting differences in velocity between reflected components of each of said plurality of input signals to determine a curvature of said pipeline along said longitudinal axis.

50. The method of 29 further comprising, generating an electromagnetic waveform as said input waveform.

51. The method of claim 29 further comprising, generating an acoustic waveform as said input waveform.

52. The method of claim 29 further comprising, generating said input waveform as one of a spread spectrum waveform, a chirp waveform, and a soliton waveform.

53. The method of claim 29 further comprising, generating said input waveform as a wideband waveform.

54. The method of claim 29 further comprising, calibrating said analyzer to be temperature stable.

55. (Amended) A method of determining a location of a point along a pipeline, said method comprising,

transmitting an input waveform having a selected input energy along a longitudinal axis of said pipeline,

receiving a reflected component of said input waveform from said pipeline, said reflected component having a characteristic reflected energy, and

comparing said input waveform with said reflected component of said input waveform to determine said location of said point along said pipeline,

wherein the transmitting, receiving, and comparing steps occur in a fashion that is non-invasive to the pipeline.

56. (Amended) A method of inspecting a characteristic of a pipeline, said method comprising,

transmitting an input waveform having a selected input energy along a longitudinal axis of said pipeline,

receiving a reflected component of said input waveform from said pipeline, said reflected component having a characteristic reflected energy, and

determining said characteristic of said pipeline using an error estimate, said error estimate depending on a known point along said pipeline relative to said characteristic,

wherein the transmitting, receiving, and determining steps occur in a fashion that is non-invasive to the pipeline.

57. The method of claim 56 wherein said error estimate further depends on one of a conductance, a radius, and a cross-sectional shape of said pipeline.

58. (Amended) A method of inspecting a characteristic of a pipeline, said method comprising,

generating an input waveform,

launching said input waveform into said pipeline,

receiving from said pipeline a reflected component having a characteristic reflected energy of said input waveform,

calculating a mathematical function of said characteristic reflected energy from said reflected component of said input waveform,

determining a model mathematical function of model reflected energy from a model component of a model input waveform, and

determining said characteristic of said pipeline by comparing said mathematical function of said reflected energy to said model mathematical function of said model reflected energy,

wherein each step is performed in a fashion that is non-invasive to the pipeline.

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